Made with Japan

A Partnership on the Frontiers of Aerospace
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MESSAGE FROM THE BOEING JAPAN PRESIDENT

Boeing has been doing business in Japan for 60 years. During that time, we have built close and enduring partnerships based on trust and mutual respect across a broad range of Japanese aerospace, government, and civil society stakeholders, in both commercial airplanes and our defense and security businesses. Working together, we have achieved much over the years, so much so that Boeing is proud to say many of our products are “Made with Japan.”

This “Made with Japan” aspect of Boeing products has long been a source of differentiation and competitive advantage. In commercial aircraft, Japan is an indispensable partner for us—to use the words of Boeing Chairman, President and CEO Jim McNerney, “We cannot imagine a Boeing commercial aircraft without Japanese involvement.” All Boeing commercial airplanes have Japanese content, and the contributions of Mitsubishi Heavy Industries, Kawasaki Heavy Industries, and Fuji Heavy Industries make Japan the single largest international country contributor in Boeing’s global supply chain. Japan’s airlines are some of Boeing’s oldest, largest, and most-valued customers, and were instrumental in the development of new Boeing airplanes, such as the 787 Dreamliner.

Our commercial airplane products are not the only ones to enjoy the “Made with Japan” label. Under a licensed production agreement, approximately 200 F-15 fighter jets were built by Mitsubishi Heavy Industries, helping to ensure the security of the skies of Japan. In the same way, Kawasaki Heavy Industries has produced nearly 100 Chinook helicopters so far, which have been used by Japan’s Self-Defense Forces during humanitarian and rescue missions around the world, as well as in Japan.

“Made with Japan” is more than just products. It is about people, jobs, and values. The Boeing-Japan partnership underpins thousands of hi-tech aerospace jobs in Japan, making it the very foundation of the local industrial base. In 2012, Boeing spent $4 billion for goods and services; as we have announced production rate increases, this spending will grow in 2013 and beyond. Working together, we push the boundaries of what is possible to create more value for our customers, foster technological innovation, and continuously improve manufacturing processes and systems.

Boeing also maintains close relationships with the Government of Japan’s Ministry of Land, Infrastructure Transport and Tourism (MLIT) and the Japan Civil Aviation Bureau (JCAB) to help ensure ever safer air transportation. The Ministry of Economy, Trade and Industry (METI) is another key partner in terms of Boeing’s collaboration with Japan’s aerospace industry.

At Boeing, rather than focusing solely on growing our business, we aim to be a trusted partner in the local communities in which we operate. Each year, Boeing Japan makes a series of charitable grants to local nonprofit organizations in the following five areas of activity: Education, Health and Human Services, the Environment, Arts & Culture, and Civic Engagement, in addition to an annual volunteer project through our Global Month of Service initiative. And our university engagements—with the University of Tokyo, Nagoya University, and Tohoku University—encompass programs focused on improving and promoting Science, Technology, Engineering, and Mathematics (STEM) education, as well as R&D collaborations to advance the state of the art in key aerospace technologies.

In Japan, the age at which one is said to have come full circle is 60 years old. As we embark on the next era of the Boeing-Japan partnership, we hope to build on successes achieved and lessons learned to work ever more closely with all of our partners, customers, and stakeholders, and become even more integrated into the local communities we serve, to the mutual benefit of us all. As Jim McNerney aptly said, “Boeing needs Japan, and Japan needs Boeing—we have a shared destiny.”

George L. Maffeo
President, Boeing Japan
THE BOEING COMPANY

Founded in 1916, Boeing is the world’s leading aerospace company and the largest manufacturer of commercial jetliners and military aircraft.

Starting as the Boeing Airplane Co., building floatplanes near Seattle, the company grew to be the world’s foremost manufacturer of commercial airplanes and a provider of military hardware by the latter half of the 20th century. Changes in the U.S. defense landscape following the end of the Cold War and cycles in the commercial airplanes market moved Boeing to join forces with other players across the industry, creating the world’s largest aerospace company.

With its balanced portfolio of commercial, defense, and space-related products and services (see 1), and revenue in excess of $80 billion, present day Boeing is one of the largest U.S. exporters. It provides products and support services to customers in 150 countries.

In addition to commercial and military aircraft, the company designs and manufactures rotorcraft, electronic and defense systems, missiles, satellites, launch vehicles, and advanced information and communication systems. As a major service provider to NASA, Boeing is the prime contractor for the International Space Station.

The Company also provides numerous military and commercial airline support services.

With corporate offices in Chicago, Boeing employs more than 170,000 people across the United States and in 70 countries. In addition, our enterprise leverages the talents of hundreds of thousands of skilled people working for Boeing suppliers worldwide.

<table>
<thead>
<tr>
<th>Corporate Profile</th>
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<tr>
<td>Headquarters</td>
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<td>Employees</td>
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<tr>
<td>Sales in 2012</td>
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<td>Commercial airplanes</td>
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<tr>
<td>Defense, Space &amp; Security</td>
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<td>Number of countries served</td>
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(1) Sales by Segment in 2012

Boeing Japan
A Legacy Born from Delivering the Very Best

After 60 years of doing business together, Boeing and Japanese industry are more than mere partners; we are part of the fabric of each other’s aerospace heritage.

Boeing opened its doors in Japan in 1953, just two years after Kawasaki Heavy Industries (KHI) and Showa Aircraft were contracted by the U.S. government to maintain U.S. military aircraft—a move that restarted Japan’s aircraft industry. Boeing’s first industrial collaborations came soon afterwards. Mitsubishi Heavy Industries (MHI) began producing the F-86 Sabre Jet fighter under license in 1956, and KHI the Vertol helicopter in the early 1960s. These were the first of several very successful defense-related licensed production projects that culminated in locally produced F-15 fighters, and Chinook and Apache rotorcraft.

Japanese industry naturally segued from defense to commercial with the 747—which went on to be the most-loved aircraft ever by the Japanese—and grew its contribution to the massive 35% work share on the 787 airframe structure enjoyed today. But the partnership is more than just size of contribution. With the 787, Boeing for the first time entrusted major elements of design as well as production to its partners. And thanks to “Working Together” with our launch customer ANA and early customer JAL, the Japanese heritage of the 787 is even more apparent.

For present day Boeing, Japan means more than airplane production. We have initiated R&D projects with industry, university, and government agency partners to benefit the local aerospace industry and Boeing, as well as Japanese manufacturing as a whole. Through our collaboration with the country’s top universities, we encourage passion and curiosity in the bright young minds of today, so that they may become the aerospace pioneers of tomorrow. And as a good corporate citizen, we are working to make a difference in local Japanese communities. By helping to make our Japanese stakeholders more successful, we are investing in the success of Boeing for the next 60 years.
**CHRONOLOGY**

1953 Boeing opens its first office in Japan.
1956 MHI starts licensed production of F-86 Sabre Jet fighter. MHI goes on to manufacture over 300 fighter planes.
1958 The JMSDF deploys the R4D-6Q training fighter.
1959 Vertol and KHI sign V-107 Helicopter license agreement. A half year later, Boeing acquires Vertol and forms the Boeing Vertol division.
1962 JASDF decides to deploy Nike J surface-to-air missile.
1964 JAL and ANA order their first Boeing aircraft, the 727. Goes into service with ANA in the same year and with JAL in 1965.
1965 KHI starts licensed production of the 107 model helicopter developed by Vertol. Production run: 160.
1966 MHI starts licensed production of the F-4 Phantom, of which MHI will manufacture 138.
1968 ANA orders the 737.
1970 JAL takes delivery of its first three 747s.
1974 Delivery starts on a total of 14 RF-4E Reconnaissance aircraft, purchased under a Foreign Military Sale agreement.
1978 Toa Airways (now part of JAL) orders its first MD-80. Goes into service in 1981.
1979 ANA introduces the 747 into its fleet. JMSDF starts to procure the Harpoon battleship missile. ANA orders the 767.
1980 JAL orders the 767.
1984 KHI starts licensed production of the CH-47 Chinook. Almost 100 manufactured to date.
1990 JAL and ANA introduce the latest, largest, and most-efficient 747 derivative—the 747-400—into their fleets.
1993 MoD decides to procure four E767 AWACS. Maintenance by KHI with Toshiba support.
1998 JASDF’s first and second E-767 AWACS go into service.
1999 JASDF’s third and fourth E-767 AWACS go into service.
2001 FHI starts licensed production of AH-64 Apache Longbow. 10 manufactured to date.
2003 JASDF signs a procurement deal for the first of four KC-767 tankers.
2005 Nippon Cargo Airlines (NCA) and Cargolux order the 747-8, launching from the program with Boeing.
2006 FHI delivers the first AH-64D Apache attack helicopter to MoD.
2007 Boeing starts to deliver JDAM to JASDF.
2008 Boeing delivers the first and second KC-767 tankers. KHI in charge of maintenance.
2009 Boeing delivers the third KC-767 tanker. Achieves IOC to start mission. Boeing also delivers a RARO systems simulator to JASDF.
2010 Boeing signs an MOU with JAXA for research into clear air turbulence warning systems.
2011 FHI delivers the 10th AH-64D. Boeing upgrades AWACS radar. ANA takes delivery of the world’s first 787 Dreamliner in September and commences the world’s first commercial service one month later.
2012 JAL becomes the second airline in the world to take delivery of the 787 Dreamliner. An ANA 787 is delivered using biofuel.
2013 MHI/Boeing/Insitu (Boeing’s subsidiary)/Sojitz deliver two ScanEagle systems to MoD.

**Note:** McDonnell Douglas-produced aircraft are included in this chronology as Boeing merged with that company in 1997.
INDUSTRY PARTNERSHIPS

**Technology Excellence**

Boeing’s relationship with Japanese industry started in 1956, when MHI commenced the licensed production of the F-86 Sabre Jet fighter. The relationship continued to grow and flourish over the coming years in both the defense and commercial arenas, as Boeing expanded the number of programs on which it collaborated with Japanese industry, as well as the number of partners. During those years, Boeing transferred new technology to Japan and, in turn, Japan used that acquired technology in support of Boeing programs.

![Japanese Industry Work-Share on the 787](image)

**Things We Have Done Together**

The results of Boeing’s Supplier of the Year Award provide a glimpse into how Boeing views Japanese technology and quality management. Since the inception of the award, 20 years ago, Japanese suppliers have accounted for 42% of non-U.S. winners, making Japan far and away the second-biggest country to receive the accolade (See 1).

Thanks to this relationship and its success as a supplier partner, Japan— which began its foray into Boeing’s commercial airplane supply chain by providing simple parts for the 747—was entrusted with the manufacture of 16% of the 767 airframe, rising to 21% of the 777 and 35% of the 787. Japan’s heavy industry players are true partners and along with Boeing derive benefit from the collaboration. When MHI was also awarded the design and manufacture of the 787 wing, it was the first time that Boeing entrusted such a critical component outside the Company.

Equally on the defense side, Boeing has built strong relationships with Japanese industry through the licensed production of the F-4, F-15, CH-47 Chinook, and AH-64 Apache helicopters. When Japan’s Tohoku region was hit by the magnitude 9.0 earthquake, resulting in the tsunami and nuclear crisis of March 2011, the JSDF’s Boeing helicopters and other aircraft were deployed as part of the disaster response and used in the attempt to cool the damaged nuclear reactors.

ScanEagle, an unmanned aerial vehicle (UAV) well suited for use in disaster situations, was procured by the government after the crisis. It was modified by MHI and delivered to Japan.

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1. Boeing Supplier of the Year Winners—Broken Down by Country (excluding the U.S.)

- **Japan**: 42%
- **Canada**: 6%
- **U.K.**: 6%
- **Germany**: 6%
- **Australia**: 8%
- **Other**: 30%

2. Japanese Industry Work-Share on the 787

- **767**: 16%
- **777**: 21%
- **787**: 35%

3. Japanese Industry Work-Share Growth (%)
the Japan Ground Self-Defense Force in 2013. Many of the products built by Boeing and our partners under license have thus contributed to the defense and security of the Japanese homeland, disaster response, and international Peacekeeping Operations (PKO).

**Contributing to Japan’s Economy**

Japan has also grown to be Boeing’s second-largest source of goods and services after the United States. In 2008, Boeing spent $1 billion per annum in Japan, and by 2013 this had increased to $4.3 billion (approx. ¥430 billion). By 2015, Boeing estimates that spending could grow to over $5 billion (see 4).

The relationship with Boeing has significant meaning for Japan’s aerospace industry. According to a survey conducted by the Society of Japanese Aerospace Companies (SJAC) in July 2013, Japanese aerospace production increased by more than 12.5% compared with the previous year, and employment in the sector by 10% during the same period. SJAC forecasts that production will further increase by more than 20% in the coming fiscal year, and attributes this growth in output and employment to increased 777 and 787 production.

It is important to note that as their involvement in production increased over time (see 3), Japan’s aerospace companies also became more involved in the design of key airplane structures and related technology (see 2). Japan’s aerospace industry is a critical business partner for Boeing, and Boeing anticipates that we will continue to grow together in the future for our mutual benefit, as we have done in the past.

According to a job creation survey conducted periodically by Boeing Japan, jobs in support of Boeing programs in the central Japan aerospace cluster increased by 40% between 2011 and 2012 (see 5). This coincides with the Japanese government’s policy to increase employment in the Central Japan Aerospace Special Economic Zone from 15,000 in 2010 to 20,000 in 2015.
Japanese airline customers ANA and JAL bought their first Boeing commercial airplanes in 1964—the 727. From that point onwards, Boeing has grown to enjoy a more than 80% share of Japan's commercial airplane market as the favored manufacturer of seven airline customers. But it was in 1966 when JAL made the decision to order the 747 that Boeing really became a household name in Japan.

Japan and the 747 share a magnificent history. JAL took delivery of the 28th 747 ever produced in April 1970. Since then, JAL went on to be the biggest operator of the 747 in the world at one point. Together with JAL and ANA, Boeing designed a high density version of the 747 just for the Japanese market—the 747-100SR, which went into service in 1973. With smaller fuel tanks and a greater payload, it allowed Japan’s airlines to carry around 500 passengers at one time. It became the symbol of the era of mass domestic transit that accompanied the incredible growth of the Japanese economy in the 1970s. It was also a symbol of the special trust between Japan and Boeing, as the company has never made a special variant of its aircraft for any market other than Japan.

The 747 has always occupied a special place in the hearts of the Japanese people. The name “Jumbo Jet,” by which the 747 is affectionately known the world over, was even coined in Japan.

It is a similar success story for Boeing’s other major new products as they were introduced: ANA became the biggest operator of the 767 outside the U.S., and along with JAL was part of the launch group of the 777.

Fast-forwarding to the present day, Boeing is still privileged to enjoy a similar position. ANA and Boeing launched the 787 with the single-biggest launch order for an all-new product in Boeing’s history. It was also the first time that a Boeing aircraft was launched in the Asia-Pacific region, the most dynamic aviation market in the world. JAL was also an early adopter of the game-changing 787, and with ANA helped shape the airplane through its development.

Japan’s airlines and Boeing are not only changing the way the public flies, but are also changing their networks to take advantage of the strategic benefits of the 787. As with the 747, so with the 787—the shared legacy continues.

See p. 5 Chronology.

What ANA Passengers Have to Say about the 787 Dreamliner

Naoko Yamamoto, ANA Public Relations
We were the first airline to put the 787 into commercial service and asked passengers flying on our Tokyo-Frankfurt route about their experience. They’re ratings were very favorable:
- over 94% said that the 787 met or exceeded their expectations
- over 94% said that they prefer the 787 to other aircraft
- 99% said that they would like to fly the 787 again with ANA or another airline

What a JAL Pilot Has to Say about the 787 Dreamliner

Exceptional fuel efficiency and very comfortable interior
Captain Ryo Ogawa, JAL Pilot
The further you fly the 787 Dreamliner, the greater its fuel efficiency. I used to fly 777s between Tokyo and New York and now operate on Tokyo-Boston. The difference in the amount of fuel the 787 uses is truly impressive. And our passengers really like the quietness of the interior and the comfortable flight. The 787 is going to be one of the mainstays of our fleet for sure.
787 Dreamliner

Breakthrough Technologies Giving Unrivalled Efficiency and Environmental Performance

At Boeing, we do not just use technology for technology's sake: innovations are carefully applied where they add value to airlines and passengers in a compelling package of super-efficiency and comfort.

Unrivalled Economic Performance

- **New Era in Fuel Efficiency: minus 20-25%**
  - Fuel efficiency is what this airplane is all about. The 787 is 20-25% more fuel efficient than similarly sized airplanes.

- **Lower Operating Costs: minus 10-15%**
  - The 787, with more-efficient engines, a lighter structure made from advanced materials, and more electric systems, reduces operating costs per seat by 10-15% in comparison with other aircraft in its class.

- **Lower Maintenance Costs: minus 30%**
  - Because composites do not fatigue or corrode and because they are more damage resistant, the 787 has 30% lower airframe maintenance costs.

Unrivalled Environmental Performance

- **A Quieter Airplane: minus 60%**
  - Noise is also an important element. The 787’s advanced engines reduce noise both inside and outside the aircraft. The 787 has a 60% smaller noise footprint on landing and takeoff than other aircraft in its class, confining its footprint within the airport boundaries.

- **Fewer CO₂ Emissions: minus 20-25%**
  - CO₂ is emitted when fuel is consumed, and accelerates global warming. The fuel-efficient 787 lowers CO₂ emissions by 20-25%. The 787 also has lower nitrogen oxide emissions. It not only falls well within current industry standards, it also clears more-stringent regulations to be implemented in the future.

The technologies on the 787—many of which were developed with our industry partners in Japan—represent a huge leap forward that will carry Boeing commercial aircraft well into the next decade of commercial airplane development. This can already be seen in the 747-8, whose wings, engine, and cabin interior are based on the technologies of the 787. The same innovations are driving the 737 MAX and the 777X. Boeing’s strategy is to offer a product lineup that is the most comprehensive and flies further, with greater efficiency and less environmental impact than competing offerings—well into the future.

Comfortable interior, greater fuel efficiency than expected

**Mr. Osamu Shinobe, President & CEO, All Nippon Airways**

Many passengers have chosen to fly in our 787’s since the fall of 2011, when ANA became the first airline in the world to take delivery of and start operating the 787. In addition to increased interior comfort, the 787 is 21% more fuel efficient than the 767s we operate on international routes. This far exceeds our initial expectation.

The 787 is a strategic aircraft that our future depends on.

**Mr. Yuji Koyama, Group leader, Flight Route Planning Group, JAL**

The 787 is a strategic choice for us. It is a medium-sized aircraft that can fly long-haul routes that were hitherto the realm of large aircraft, and it enables us to fly to new destinations and increase flights at different times to existing destinations. Combine that with superb economic performance and you have an airplane that directly contributes to improved profitability. In my opinion, the 787 is a wonderful airplane that not only allows us to strengthen our network and improve our bottom line, but also allows us to increase passenger convenience.
Boeing Commercial Aviation Current Market Outlook
2013–2032

• World air passenger traffic growth average: 5% annually
• Long-term demand for 35,000 new airplanes

Every year, Boeing analyzes key indicators, including the price of oil, market liberalization, airplane capabilities, airline strategies, emerging markets, economic growth, and environmental factors to create its market outlook for the following 20 years.

Air travel and economic growth are directly related—more people fly as economies grow. Global GDP is projected to grow at 3.2% per annum between 2013 and 2032, driving worldwide air passenger traffic to an average of 5% annual growth and creating demand for 35,000 new aircraft worth a total of $4.8 trillion. Growth in the Asia-Pacific region will lead the rest of the world.

Airline strategies will decide the selection of airplane type. Low Cost Carriers are driving the need for 24,670 single aisle airplanes over the next 20 years—70% of new airplane demand. Up to 41% of those airplanes will be for replacement, with 59% new-builds used to expand fleets. Network carriers are driving demand for a global total of 7,830 new twin aisle wide body airplanes, such as the 767, 777, and 787. While these airplanes account for 22% of deliveries, they make up 45% of the value of the $4.8 trillion market.

Pilot and Technician Forecast
by 2032 the world will require:

• 498,000 new commercial airline pilots
• 556,000 new commercial airline maintenance technicians

In its 2013–2032 pilot and technician forecast, Boeing projects growing demand for pilots worldwide, driven by steadily increasing airplane deliveries, particularly single aisle airplanes. This represents a global requirement for about 25,000 new pilots annually.

As an industry, it is critical that we enhance our training methods with the latest, cutting-edge technologies and show the attraction of careers in aviation to young people, in order to attract and retain the brightest and best.

Global demand for technicians remains significant, at approximately 28,000 new technicians required annually. However, the introduction of more-efficient and smarter airplanes will require fewer mechanics over time.
Boeing Manufactures both new and converted freighters from 18 tons to 134 tons to meet a variety of customer needs. Currently, the company has a share that is greater than 90% of the freighter market share.

**Boeing Freighter Lineup and Specifications**

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<tr>
<th>Type</th>
<th>Payload</th>
<th>Range</th>
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<tr>
<td>747-8F</td>
<td>133.9</td>
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<tr>
<td>747-400ERF</td>
<td>112.7</td>
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<tr>
<td>747-400F</td>
<td>112.6</td>
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<td>747-400BCF</td>
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</tr>
<tr>
<td>737-700C</td>
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The new 747-8 Freighter offers the lowest ton-kilometer cost of any large commercial freighter on the market. It boasts a cargo capacity of 134 tons and a range of 8,010 km as well as superb fuel efficiency, operating costs, and environmental performance.

**747-8 Freighter**

The new 747-8 Freighter can carry 16% more volume, the equivalent of four more pallets on its main deck and three more pallets in the lower hold, than the 747-400 Freighter that it replaces. It has an integrated Onboard Weight & Balance System to provide real-time information and a fully digitized control system. The aft cargo door can handle cargo as high as 3m. The 747-8 Freighter also retains the unique nose door of its predecessor, which can handle freight longer than 6.1 meters—at a premium of up to 50% more per ton.

**Boeing Air Cargo Current Market Outlook, 2013–2032**

- Global air cargo traffic annual growth: 5%
- 2,300 freighters needed

Boeing’s more-than-90% share of the cargo market has been obtained by accurate forecasting of the market and a sound product strategy to match. Air cargo traffic, measured in revenue ton-kilometers, is projected to average 5% annual growth over the next 20 years. Global economic growth and the need to replace aging airplanes will create a requirement for 2,300 freighters over the same period. Of these, 1,450 will be converted from passenger aircraft. The remaining 850 airplanes will be new-builds valued at $240 billion. The world freighter fleet is expected to increase from 1,730 airplanes in 2013 to 2,810 in 2032.

**747-8 Freighter will add value**

Mr. Sakamoto Fukashi, President & CEO, Nippon Air Cargo

Although the global air cargo market is getting tougher, thanks to our new Boeing 747-8 Freighters with their excellent operating, economic, and environmental performance, we at NCA intend to offer high-quality, high-value cargo services to our customers.
Commercial Aviation Services (CAS)

The Boeing Edge
Boeing is committed to giving customers value and advantage by offering a portfolio of products, services, and support after the delivery of its airplanes, known collectively as “The Boeing Edge.” The Boeing Edge is provided by Boeing’s Commercial Aviation Services (CAS). It comprises four business units aimed at helping airlines maximize the lifetime value of their fleets and operations.

Material Services: Boeing supports the delivery of spare parts and services to customers, including inventory and warehouse management. Airline customers can decrease the risk of owning spare parts warehouses thanks to the global scale of Boeing’s customer base. The Boeing Spare Parts Distribution center located in Seattle operates 24/7, providing spare parts whenever customers need them.

Fleet Services: Approximately 330 Boeing staff in more than 60 countries support airline customer fleets around the clock. Our Fleet Services staff provides the technical information and expertise that customers need to manage individual airplanes, fleets, and overall operations, including flight operations, upgrades, and modifications—all services required to meet customers’ emerging needs. Airline customers look for a differentiator. Boeing can upgrade airplanes or change the interior configuration for them to remain competitive.

Flight Services: Boeing offers airline customers a broad range of flight operations solutions to drive optimized performance, efficiency, and safety, such as pilot training and simulator support. Through subsidiary Jeppesen, Boeing provides flight charts for pilots. Its technically advanced Tools, such as the electronic Flight Bag and applications for viewing charts on mobile devices like iPad, can replace paper, potentially saving hundreds and thousands of gallons of jet fuel as well as trees. Pilots can update route information online.

Information Services: Boeing is leading the industry by strengthening system technology and online access to information, products, and services with Information Services. Through the use of digital tools such as RFID and myboeing-fleet.com, Boeing is improving the safety of airline operations. For example, if an aircraft experiences trouble while in flight, data can be transmitted during flight so that the airplane can be repaired as soon as it lands, increasing efficiency dramatically. Boeing forecasts strong growth for commercial services over the coming 20 years, valued at $2.4 trillion.
Strong Partnership with Japan’s Defense Industry

Boeing and Japan’s aerospace industry have built a long-lasting relationship which is underpinned by the strong U.S.-Japan security alliance. Starting from MHI’s production of the F-86 Sabre Jet fighter, Japanese companies have manufactured and maintained many of Boeing’s defense programs under license.

Through such licensed production relationships, Boeing transferred technology that contributed to the growth of Japan’s own expertise and its aerospace industry. In the early days, Japanese engineers also visited Boeing to learn about manufacturing. These kinds of exchanges—of people, technology, and ideas—became the very foundation of today’s relationship. Ties were further strengthened when Boeing entered its second strategic partnership agreement for 10 years with its three heavy industry partners—MHI, KHI, and FHI—in 2010, to reaffirm their continued collaboration and common goals.

Working with Japan’s Defense Industry to Defend Japan

Many of the programs provided by Boeing and its Japanese industrial partners support the Japan Self-Defense Forces (JSDF) in defense, disaster response, and Peacekeeping Operations (PKO). The F-15J/DJ Eagle fighter aircraft, CH-47J/JA Chinook, and AH-64D Apache helicopters were manufactured by Japanese heavy industry partners under licensed production agreements with Boeing. Also, Foreign Military Sales (FMS) programs, such as the E-767 AWACS and KC-767 Tanker, are maintained by KHI, and support Japan’s defense missions.

The Japanese government has operated two 747-400 airplanes for state business since 1992. Boeing modified the commercial airplane platforms to fit state specifications. These so-called Japan VIP aircraft are operated by the Japan Air Self-Defense Force (JASDF) and used to transport dignitaries, participate in PKO as well as for humanitarian response missions.

The Japanese government decided to introduce Unmanned Aerial Vehicles (UAVs) for use in disaster relief operations based on lessons learned during the magnitude 9.0 earthquake that occurred in northeastern Japan in 2011. It procured two ScanEagle systems (manufactured by Insitu, a subsidiary of the Boeing Company) that Insitu/Boeing and MHI delivered to the Japan Ground Self-Defense Force (JGSDF) in the spring of 2013.

KC-767 Tanker
- operated by the JASDF
- maintained by KHI

F-15J/DJ
- operated by the JASDF
- produced under license and maintained by MHI

E-767 AWACS
- operated by the JASDF
- maintained by KHI

AH-64D Apache
- operated by the JGSDF
- produced under license and maintained by FHI

Photo: KOKU-FAN magazine
Boeing’s New Defense Business

Cybersecurity
With one of the largest corporate IT portfolios in the world, Boeing’s network supports more than 170,000 employees and connects with suppliers around the world. By developing, deploying, and defending complex systems for customers, Boeing has cultivated a unique value proposition in cybersecurity. In Japan, Boeing is working with Sojitz, a Japanese trading company, to offer cybersecurity solutions.

Since September 2013, the University of Aizu has deployed Boeing’s Cyber Range-in-a-Box, a compact cyber training and simulation tool, in Japan’s first university-level cybersecurity course.

Future Technology Development—Phantom Works
Phantom Works is a division of The Boeing Company that supports Boeing Defense, Space & Security’s cutting-edge programs and develops future technology. Phantom Works leads Boeing’s R&D initiatives along with Boeing’s Research & Technology, providing innovative solutions to meet global customer needs. Some examples of systems of the future include: the Phantom Eye high altitude surveillance UAV and Swarm Technology, which allows different unmanned vehicles to communicate with each other.
Defense Program Services

The Global Services & Support (GS&S) business unit of Boeing Defense, Space & Security is dedicated to giving customers in Japan and around the world a full spectrum of versatile products and services that provide total life-cycle solutions. GS&S delivers tomorrow’s solutions today:

- Technical support
- Parts logistics
- Training support
- Aircraft upgrades and modifications

Working with Japanese partners, GS&S is well positioned to support the installed base of Boeing programs used by Japan’s Ministry of Defense (MoD): F-4, F-15J/DJ, AH-64D, KC-767, CH-47J/JA, E-767 AWACS, and B747-400 VIP.

GS&S offers innovative, comprehensive, and affordable solutions. The business is uniquely able to support both military and commercial products and services. Its solutions lower costs and deliver low-risk, flexible, and advanced services that reach well beyond the platforms we manufacture. With expertise on Boeing and select non-Boeing platforms and access to a robust worldwide supply chain, GS&S delivers unparalleled results.
Leading the Way in Sustainable Alternative Fuels
The demand for commercial airplanes is predicted to double over the coming 20 years. To achieve that in a sustainable manner, the aviation industry is committed to carbon neutral growth by 2020, and to halving the amount of CO₂ it produces annually by the year 2050 compared with 2005 levels. Boeing is at the leading edge of these efforts, investing in new technologies to make its aircraft ever more efficient.

They include the development and production of the groundbreaking 787 Dreamliner, which reduces CO₂ emissions by 20-25%; helping infrastructure partners develop new air traffic management systems; and demonstrating the viability of sustainable alternative fuels.

Japan is also an integral part. In 2009, Boeing and JAL conducted a domestic biofuel demonstration flight using a 747-400 powered by a mixture of jet kerosene and fuel derived from camelina, jatropha, and algae. In 2012, ANA took delivery of a 787 and an NCA 747-8F, both powered in part by biofuel produced from used cooking oil. All three flights were pioneering record setters and demonstrated a significant reduction in CO₂ emissions compared with fossil fuels.

Each year, Boeing Japan hosts a series of biofuel workshops with our airline customers, inviting petrochemical and oil companies, feedstock producers, distributors, and government stakeholders. While the company is not a producer of biofuels, it is a leader in the process of certifying them as “drop in replacement fuels” for use in current technology propulsion systems, and is championing their use throughout the world to facilitate sustainable growth for the benefit of all.

Smaller Environmental Footprint
Boeing made significant improvements in its environmental performance as a manufacturer, even as total airplane deliveries increased by 50% from 2007 to 2012. Boeing’s manufacturing and office employees consumed less energy and water, reduced CO₂ emissions, generated less hazardous waste, and sent less solid waste to landfills. The environmental progress came during a time when Boeing also opened a major new manufacturing facility in North Charleston, South Carolina, and created more than 13,000 new jobs.

These significant achievements include:
• On a revenue-adjusted basis, Boeing facilitates reduced hazardous waste by 33%, CO₂ emissions by 26%, energy use by 21%, and water intake by 20% since 2007. Measured on an absolute basis, the reductions equate to 18% for hazardous waste, 9% for CO₂ emissions, 3% for energy use, and 2% for water intake. In 2012, 79% of the solid waste Boeing generated was diverted from landfills—a 136% improvement since 2007.
• Over the five-year period, Boeing achieved reductions in CO₂ emissions equal to taking 87,000 cars off the road for one year.
• Boeing is committed to zero carbon growth by 2017, while continuing to increase aircraft production.

Research and Development
Boeing is committed to working with the best technologists and manufacturing experts in the world, many of whom...
come from Japan. Research projects range from manufacturing techniques to environmentally progressive fuel cell technology to power airplane systems.

Boeing is involved in joint R&D projects with the following partners:

- Ube Industries, on new materials for aerospace applications
- Japan Aerospace Exploration Agency (JAXA), on clear-air turbulence detection using LIDAR
- The University of Tokyo, on machine vision
- IHI, on regenerative hydrogen fuel cells
- Fujikura, on direct methanol fuel cells
- Fujitsu, on RFID technology for use in aircraft maintenance

### Consortium for Manufacturing Innovation

In June 2012, Boeing and partners Mitsubishi Heavy Industries, Kawasaki Heavy Industries, Fuji Heavy Industries, and the Institute of Industrial Science (IIS) at the University of Tokyo announced the start of joint research into technologies to improve manufacturing processes and address manufacturing issues common to the four industry partners. In a new model of cooperation, the partners formed a Consortium for Manufacturing Innovation (CMI) in spring 2013. CMI is dedicated to translating success in the university laboratory into greater efficiencies on the factory floor in the shortest time possible. As the four industry partners share aerospace in common, CMI is initially working on related research. However, as membership expands CMI intends to seek like-minded partners from any manufacturing sector, under the auspices of IIS, to improve the competitiveness of Japanese industry overall.

### Higher Education Program

In addition to working with university partners on collaborative research that benefits the long-term needs of our businesses, Boeing cultivates partnerships with universities around the world.

In Japan, Boeing has selected the University of Tokyo, Nagoya University, and Tohoku University as Higher Education Partners. As such, the universities receive funding to enhance curricula and research projects.

Boeing Japan also conducts an annual series of summer seminars and an externship program for aerospace students at the three institutions. Every year, students are invited into Boeing Japan to learn about the aerospace industry and are assigned projects involving the application of aerospace technology, for example, in a disaster relief scenario.

#### Higher Education Programs

<table>
<thead>
<tr>
<th>Year</th>
<th>University</th>
<th>Project</th>
<th>Outline</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>The University of Tokyo</td>
<td>Joint R&amp;D</td>
<td>Industry-Academia collaborative R&amp;D</td>
</tr>
<tr>
<td>2010-2011</td>
<td>The University of Tokyo</td>
<td>Externship</td>
<td>Lectures and seminars by Boeing staff on the aerospace industry and related technologies</td>
</tr>
<tr>
<td>2012-2013</td>
<td>The University of Tokyo, Tohoku University, Nagoya University</td>
<td>Externship</td>
<td>Lectures and seminars by Boeing staff on the aerospace industry and related technologies</td>
</tr>
<tr>
<td>2011</td>
<td>Nagoya University</td>
<td>Joint R&amp;D</td>
<td>Industry-Academia collaborative R&amp;D</td>
</tr>
<tr>
<td>2012</td>
<td>The University of Tokyo, Tohoku University, Nagoya University</td>
<td>Higher Education Program</td>
<td>Annual funding to enhance curricula and research project</td>
</tr>
<tr>
<td>2012</td>
<td>The University of Tokyo</td>
<td>CMI Industry-Academia Joint R&amp;D</td>
<td>Joint R&amp;D consortium formed jointly by Boeing, MHI, KHI, FHI, and the University of Tokyo to improve manufacturing technology</td>
</tr>
<tr>
<td>2012</td>
<td>Osaka Institute of Technology</td>
<td>Lecture</td>
<td>Innovation</td>
</tr>
<tr>
<td>2009-2012</td>
<td>Tokyo Institute of Technology</td>
<td>Lecture</td>
<td>Process of enacting laws relating to NPOs</td>
</tr>
<tr>
<td>2012</td>
<td>Tohoku University</td>
<td>Lecture</td>
<td>Boeing’s strategy and future</td>
</tr>
<tr>
<td>2013</td>
<td>Tohoku University</td>
<td>Joint R&amp;D</td>
<td>Industry-Academia collaborative R&amp;D</td>
</tr>
<tr>
<td>2013</td>
<td>Waseda University</td>
<td>Lecture</td>
<td>The latest air transportation systems</td>
</tr>
<tr>
<td>2013</td>
<td>The University of Aizu</td>
<td>Technology Support</td>
<td>Japan’s first cybersecurity training and simulation tool</td>
</tr>
</tbody>
</table>

Boeing Summer Seminar at The University of Tokyo
Boeing’s Commitment to Local Communities

At Boeing, rather than just growing our business in the countries in which we operate, our aim is to be a trusted partner for those communities. In Japan, we formalized our corporate citizenship efforts in 2003, the year of our 50th anniversary in the country. Every year since, we have made a series of charitable grants to local NPOs and volunteer groups in the following five areas of activity: Education, Health and Human Services, the Environment, Arts & Culture, and Civic Engagement.

Examples of organizations we support include:

**Education**
- NPO The Children’s University of Kawagoe: encouraging academic interest in children
- NPO Tokyo Shure: a school for children and young adults outside mainstream education

**Health**
- Solaputi Kids Camp: where terminally ill children get to spend time in nature
- Tohoku Rainbow House Project: supports children in the Tohoku region orphaned by the March 2011 earthquake and tsunami

**Environment**
- COP 10 Japan: educates women and children about the diversity of life on earth
- Sarobetsu Eco Network: educates the next generation about the importance of environmental conservation
- NPO Grow forest in Ashio: reforestation efforts at a site devastated by environmental pollution
- NPO Protect Fujimae Tidal Flat: conservation of RAMSAR protected wetlands in Nagoya
- OISCA: reforestation of the tsunami-damaged areas near Sendai Airport

**Employee Participation**

Our activities do not end with charitable grants. Boeing employees worldwide join in volunteer activities around the date of the company’s foundation, July 16, as part of our Global Month of Service. In Japan, we try to encourage the organizations we support and colleagues from our partner companies to join with us wherever possible.

For example, children from “free school” Tokyo Shure joined us to plant trees at a site called Ashio that was devastated by environmental pollution north of Tokyo. And friends from Mitsubishi Heavy Industries (MHI) helped us to clean up the beach at the Fujimae Tidal Flat on the Nagoya coast, close to the production centers of MHI.

**Tohoku Earthquake and Tsunami**

Northern Japan was severely affected by the devastating earthquake and tsunami of March 11, 2011. Boeing employees worldwide were quick to respond with a donation of $1.3 million within days of the tragedy, which was supplemented by a further $1 million donation from The Boeing Company. The latter was split between NPOs Disabled Peoples’ International and Mercy Corps to assist disabled people in the region with much-needed infrastructure and employment creation opportunities.

Boeing volunteers also assisted in the recovery effort in the immediate aftermath of the disaster, and our Global Month of Service activities for 2012 and 2013 involved helping in Kesennuma and Watari-cho, two of the worst-affected communities.

At Boeing, giving back to the communities in which we live and work is a core value. It helps make us part of the fabric of Japan.
The 737 is the most-popular family of commercial airplanes in history. In its current iteration, the Next Generation 737 family is the most-fuel efficient single aisle aircraft flying today, and with a dispatch rate of 99.7%, it is also the most reliable.

In August 2011, Boeing launched the 737 MAX family of airplanes, to build on the Next Generation 737’s popularity and reliability while delivering customers unsurpassed fuel efficiency in the single aisle market.

The 737 MAX will deliver big savings in fuel that airlines require for the future. The new-engine variant, powered by CFM International LEAP-1B engines, reduces fuel burn and CO₂ emissions by an additional 14% over today’s most fuel-efficient single aisle airplanes. Recent design updates, including Boeing’s Advanced Technology Winglet, will result in less drag and further optimize the 737 MAX performance, especially on longer-range missions.

The 737 MAX’s more-efficient structural design, less engine thrust, and less required maintenance also will add up to substantial cost advantages for customers. The 737 MAX 8 will have the lowest operating costs* in the single aisle segment with an 8% per-seat advantage over the A320neo.

Development of the 737 MAX is on schedule. Firm configuration of the airplane was achieved in July 2013. The first flight is expected in 2016, with deliveries to customers in 2017.

The Next Generation 737 platform forms the basis for several military derivatives: the Airborne Early Warning and Control (AEW&C) aircraft equipped with a variety of aircraft control and advanced radar systems, which sets the standard for airborne early warning systems, and the P-8 anti-submarine and anti-surface warfare aircraft.

* U.S. typical mission rules; 2-class seating configuration; 737 MAX8 flying 500nm; 1 U.S. gallon of fuel = US$3.50
Boeing 767

Low operating costs, variable range capability, almost universal airport compatibility, and ETOPS capability make the 767 a versatile family of airplanes. This versatility is an extremely competitive advantage to an operator that needs to serve a variety of different missions and passenger demands.

The 767 Freighter shares all the advancements in avionics, aerodynamics, materials, and propulsion that contribute to the success of the 767-300ER passenger airplane. Excellent fuel efficiency, operational flexibility, low-noise levels, and an all-digital flight deck allow the 767 Freighter to support time-critical cargo schedules, even at airports with stringent noise and emissions standards. You can breathe easy with the 767 family. The 767s produce lower emissions per pound of fuel used than any comparably sized jetliner, including the A330-200. The 767 family beats industry standards in all categories of emissions—nitrogen oxides, hydrocarbons, smoke, and carbon monoxide.

The 767 is the base platform for the KC-767 and KC-46 tankers and AWACS military aircraft.
Boeing 777

Newer-generation 777s have experienced unrivaled success in markets across the globe, making them the flagship of the world’s most-successful airlines. The best of the best proudly fly Boeing 777s.

The 777 gives airlines the flexibility to serve and create markets that require long range, large capacity, or a combination of the two. In fact, the 777 provides both the greatest payload and the longest range of any airplane in the 300- to 400-seat category. Leaving on time is critically important, and the 777 is the benchmark for the industry. The 777 has fewer than half the schedule interruptions, turn backs, or diversions of competing twin aisle airplanes.

The 777 continues to be voted the favorite airplane of frequent travelers. Because it delivers more revenue and has low operating costs, demand for the 777 continues to outpace all other competitors combined.

Airlines and passengers can feel at ease about CO2 and the environment when flying the 777. Well ahead of today’s environmental standards, the 777 earns emission scores that are the envy of competing airplanes.

Airlines, leasing companies, and financiers are confident of demand for the 777 family as it continues to outsell all competing models. The consistently high residual value of the 777 reflects this confidence. The most-efficient and productive long-range twin-engine airplane flying today, the 777 continues to be preferred by airlines around the world.

In November of 2013, Boeing launched the 777X program, Boeing’s newest family of twin aisle airplanes that builds on the passenger-preferred and market-leading 777. The 777X will be the largest and most fuel-efficient twin-engine jet in the world, with 20% lower fuel consumption and 15% lower operating costs than today’s 777. It is slated to enter service by the end of the decade.

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**General Characteristics**

<table>
<thead>
<tr>
<th>Passenger Type</th>
<th>2-class Seating Configuration</th>
<th>Range</th>
<th>Cruise Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>777-200</td>
<td>312</td>
<td>5,120</td>
<td>9,480</td>
</tr>
<tr>
<td>777-200LR</td>
<td>314</td>
<td>9,290</td>
<td>17,205</td>
</tr>
<tr>
<td>777-300</td>
<td>314</td>
<td>5,840</td>
<td>10,820</td>
</tr>
<tr>
<td>777-300ER</td>
<td>386</td>
<td>7,825</td>
<td>14,490</td>
</tr>
<tr>
<td>777-9X</td>
<td>350</td>
<td>9,300</td>
<td>17,220</td>
</tr>
<tr>
<td>777-8X</td>
<td>400</td>
<td>8,200</td>
<td>15,185</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cargo Type</th>
<th>Maximum Load</th>
<th>Range</th>
<th>Cruise Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>777F</td>
<td>102</td>
<td>4,900</td>
<td>9,070</td>
</tr>
</tbody>
</table>

*1. At 35,000 feet
*2. Planned
Responding to the overwhelming preference of airlines around the world, Boeing Commercial Airplanes is proud to offer the 787 Dreamliner, a family of super-efficient airplanes.

The 787-8 Dreamliner can carry 210-250 passengers on routes of 7,650 to 8,200 nautical miles (14,200 to 15,200 km), while the longer 787-9 Dreamliner will carry 250-290 passengers on routes of 8,000 to 8,500 nautical miles (14,800 to 15,750 km). The new 787-10, launched in June 2013, will extend and complement the family, carrying 300-330 passengers up to 7,000 nautical miles (12,964 km), or more than 90% of the world’s twin aisle routes.

In addition to bringing big-jet ranges to midsize airplanes, the 787 family provides airlines with unmatched fuel efficiency, resulting in exceptional environmental performance. The airplane uses 20-25% less fuel than today’s similarly sized airplanes. The 787 also travels at a similar speed as today’s fastest twin aisle airplanes, up to Mach 0.85. Airlines also realize more cargo revenue capacity—a 20-to-45% advantage over similarly sized airplanes.

Passengers also enjoy improvements on the 787 Dreamliner, from an interior environment with higher humidity to more comfort and convenience.

The key to the exceptional performance of the Dreamliner is a suite of new technologies, including extensive use of composites, more-electric systems, modern engines, and advanced aerodynamics.
The new Queen of the Skies is the new 747-8 Intercontinental. The 747-8 Intercontinental carries more passengers and cargo farther and faster than any previous 747, while being cleaner, quieter, and more fuel efficient. The 747-8 features new advanced structural materials, the newest wing and engine combination in the industry, an updated flight deck, and a Dreamliner-inspired interior. Passengers will love this new oasis in the sky, and airlines will love its improved economic and environmental performance.

The 747-8 Intercontinental newly designed cabin is warm, inviting, and comfortable. The new staircase is open and flowing, and the bigger recessed overhead bins provide more storage space and more headroom. The new interior design further accents the 747’s unique spaces—the upper deck, which is quiet and preferred by business travelers, the spacious main deck, and, of course, the forward First Class area that evokes a feeling of traveling in a private jet.

The 747-8’s new wing is a state-of-the-art raked wing design with a new high-lift system. Combined with General Electric’s newest-generation GEnx-2B engine, the 747-8 can fly more efficiently consuming less fuel, emitting less greenhouse gases, and more quietly than any previous 747.

The 747-8 Freighter flies more efficiently, economically, and has better environmental performance than previous models.

### General Characteristics

<table>
<thead>
<tr>
<th>Type</th>
<th>2-class Passenger Seating Configuration</th>
<th>Range</th>
<th>Cruise Speed*</th>
</tr>
</thead>
<tbody>
<tr>
<td>747-400</td>
<td>416</td>
<td>7,260</td>
<td>13,450</td>
</tr>
<tr>
<td>747-400ER</td>
<td>416</td>
<td>7,670</td>
<td>14,205</td>
</tr>
<tr>
<td>747-8 Intercontinental</td>
<td>467</td>
<td>7,760</td>
<td>14,380</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>Maximum Load</th>
<th>Range</th>
<th>Cruise Speed*</th>
</tr>
</thead>
<tbody>
<tr>
<td>747-400F</td>
<td>112.6</td>
<td>4,445</td>
<td>8,230</td>
</tr>
<tr>
<td>747-400ERF</td>
<td>112.7</td>
<td>4,970</td>
<td>9,200</td>
</tr>
<tr>
<td>747-8F</td>
<td>134</td>
<td>4,325</td>
<td>8,010</td>
</tr>
</tbody>
</table>

*At 35,000 feet
The F-15 Eagle is an extremely maneuverable, tactical fighter designed to permit the Air Force to gain and maintain air supremacy over the battlefield.

The Eagle’s air superiority is achieved through a mixture of unprecedented maneuverability and acceleration, range, weapons, and avionics. It can penetrate enemy defense and outperform and outfight any current enemy aircraft. The F-15 has electronic systems and weaponry to detect, acquire, track, and attack enemy aircraft while operating in friendly or enemy-controlled airspace. The weapons and flight control systems are designed so one person can safely and effectively perform air-to-air combat.

A multimission avionics system sets the F-15 apart from other fighter aircraft. It includes a head-up display and advanced radar, an inertial navigation system, and flight instruments. It also has an internally mounted, tactical electronic-warfare system, an “identification friend or foe” system, an electronic countermeasures set, and a central digital computer. It can link with AWACS to be ready for interception.

The Eagle can be armed with combinations of different air-to-air weapons: AIM-120 advanced medium-range air-to-air missiles on its lower fuselage corners, AIM-9L/M Sidewinder or AIM-120 missiles on two pylons under the wings, and an internal 20mm Gatling gun in the right wing root.

The F-15C, equivalent to JASDF’s F-15J, is a single-seat fighter, while the F-15D, equivalent to JASDF’s F-15DJ, is a two-seat fighter. As it is designed to be constantly upgraded, the U.S. Air Force and many other international air forces, including Japan’s, operate it as a mainstream fighter. The F-15 Strike Eagle, its derivative version, is also deployed by not only the U.S. Air Force but also by other international air force customers.

General Characteristics

<table>
<thead>
<tr>
<th>Crew</th>
<th>F-15A/C: one, F-15B/D/E: two</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wingspan</td>
<td>49.8 ft. (15 m)</td>
</tr>
<tr>
<td>Length</td>
<td>63.8 ft. (19.44 m)</td>
</tr>
<tr>
<td>Height</td>
<td>18.5 ft. (5.6 m)</td>
</tr>
<tr>
<td>Speed</td>
<td>1,875 mph (Mach 2.5 class)</td>
</tr>
<tr>
<td>Range</td>
<td>3,450 miles (3,000 nautical miles) ferry range with conformal fuel tanks and three external fuel tanks. More than 4,630km extra fuel tank. More than 5,750km (CFT)</td>
</tr>
<tr>
<td>Power plant</td>
<td>Two Pratt &amp; Whitney F100-PW-100, 220, or 229 turbofan engines with afterburners</td>
</tr>
<tr>
<td>Thrust</td>
<td>(C/D models) 23,450 lb.s each engine</td>
</tr>
</tbody>
</table>
KC-46 Tanker

The KC-46 Tanker program provides a new generation in air refueling for the U.S. Air Force and international customers, offering greater capability, improved efficiency, and a tanker that is combat-ready on day one. With unparalleled multi-role capability, the KC-46 will deliver more fuel, cargo, passengers, and aeromedical patients. The KC-46 features an advanced, fly-by-wire boom with an expanded greater refueling envelope and faster offloads for improved mission effectiveness. Integrated hose and drogue systems, wing air refueling pods, and a refueling receptacle enable simultaneous multi-point refueling and tanker-to-tanker refueling for extended range and flexibility. The KC-46’s air refueling operator station features dual, independent controls with high resolution 24” 3D displays.

The KC-46 offers a state-of-the-art flight deck with pilot displays from the 787 Dreamliner and integrated threat and warning systems, enabling the crew to have instant access to the information needed for pilots to make real-time, critical decisions. The program’s integrated logistics support system provides Interim Contract Support to secure initial operational capability with follow-on support options ranging from a Performance-Based Logistics approach to facilitating customer-based organic capability.

<table>
<thead>
<tr>
<th>General Characteristics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Crew</td>
<td>4-15</td>
</tr>
<tr>
<td>Wingspan</td>
<td>156.1 ft.</td>
</tr>
<tr>
<td>Length</td>
<td>165.6 ft.</td>
</tr>
<tr>
<td>Height</td>
<td>52.10 ft.</td>
</tr>
<tr>
<td>Max airspeed</td>
<td>360 KCAS/80M</td>
</tr>
<tr>
<td>Power plant</td>
<td>Pratt &amp; Whitney 2 x F 100-PW-4062</td>
</tr>
<tr>
<td>Thrust</td>
<td>62,000 lb.s</td>
</tr>
<tr>
<td>Maximum takeoff weight/distance</td>
<td>415,000 lb.s</td>
</tr>
<tr>
<td>Fuel capacity</td>
<td>212,299 lb.s</td>
</tr>
</tbody>
</table>
The 737-700 is one of the most popular and reliable jet aircraft in the world. 737 Airborne Early Warning and Control (AEW&C), its military derivative, has the following characteristics.

- The 21st-century avionics, navigation system and flight deck
- Operational ceiling: 41,000 ft.
- Range: 3,500 nm
- Flight hours: 10.5 hours, with aerial refueling 20 hours

The AEW&C system includes the following elements:

- Multi-role electronically scanned array (MESA) radar system
- A steerable beam, L-band, electronically scanned array that provides optimal performance in range, tracking, and accuracy
- Radar that can track airborne and maritime targets simultaneously
- Assistance to the mission crew in directing the control of high-performance fighter aircraft while continuously scanning the operational area
- A "top hat" portion that provides a practical solution for fore and aft coverage while maintaining the low-drag profile of the dorsal array system—enabling the MESA system to be installed on the mid-size 737-700 platform without significant impact to aircraft performance

General Characteristics

<table>
<thead>
<tr>
<th>Crew</th>
<th>Flight crew: 6–10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum takeoff weight</td>
<td>71,000 lbs</td>
</tr>
<tr>
<td>Maximum speed</td>
<td>Mach 0.78</td>
</tr>
<tr>
<td>Range</td>
<td>3,500 nm</td>
</tr>
<tr>
<td>Radar</td>
<td>Northrop Grumman MESA electronically scanned array radar system: 360 degrees/ Air and maritime modes</td>
</tr>
</tbody>
</table>

The 737 airborne early warning and control (AEW&C) system encompasses both the Boeing 737-700 aircraft platform and a variety of aircraft control and advanced radar systems. Consisting of components created by Boeing and Northrop Grumman, the 737 AEW&C represents the standard for future airborne early warning systems. Australia, Turkey, and South Korea have purchased cumulatively 14 737 AEW&C systems.
The AH-64E Apache is the newest and most-advanced version of the world’s most-powerful attack helicopter. It incorporates all the capabilities resident in the AH-64D Apache while adding new technologies or improving the aircraft’s capabilities.

The first AH-64E was delivered to the U.S. Army in October 2011. The U.S. Army plans to operate its AH-64E fleet for 25-30 years, with production of Apaches for the U.S. Army continuing well into the next decade.

Among the AH-64E Apache’s enhancements are a new drivetrain, engine, and avionics, open systems architecture, and increased network-centric capability. The AH-64E features increased survivability and the ability to conduct maritime operations.

**General Characteristics**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crew</td>
<td>2</td>
</tr>
<tr>
<td>Wingspan</td>
<td>17.15 ft (5.227 m)</td>
</tr>
<tr>
<td>Length</td>
<td>58.17 ft (17.73 m)</td>
</tr>
<tr>
<td>Height</td>
<td>15.24 ft (4.64 m)</td>
</tr>
<tr>
<td>Weight</td>
<td>15,075 lb (6,838 kg)</td>
</tr>
<tr>
<td>Engine</td>
<td>GE-701D</td>
</tr>
<tr>
<td>Cruise speed</td>
<td>150 kt (279 kph)</td>
</tr>
</tbody>
</table>

**AH-64E Apache Attack Helicopter**
The CH-47F is an advanced multimission helicopter for the U.S. Army and international defense forces. It contains a fully integrated, digital cockpit management system, a Common Aviation Architecture Cockpit, and advanced cargo-handling capabilities that complement the aircraft’s mission performance and handling characteristics.

The CH-47F is also widely used for disaster response and humanitarian missions as well as Peacekeeping Operations.

<table>
<thead>
<tr>
<th>General Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crew</td>
</tr>
<tr>
<td>Width</td>
</tr>
<tr>
<td>Length</td>
</tr>
<tr>
<td>Speed</td>
</tr>
<tr>
<td>Fuel</td>
</tr>
<tr>
<td>Service ceiling</td>
</tr>
<tr>
<td>Useful load</td>
</tr>
<tr>
<td>Mission radius</td>
</tr>
<tr>
<td>Propulsion</td>
</tr>
</tbody>
</table>
The V-22 Osprey is a joint service multi-role combat aircraft utilizing tilt-rotor technology to combine the vertical performance of a helicopter with the speed and range of a fixed wing aircraft. With its engine nacelles and rotors in vertical position, it can take off, land, and hover like a helicopter. Once airborne, its engine nacelles can be rotated to convert the aircraft to a turboprop airplane capable of high-speed, high-altitude flight. This combination allows the V-22 to fill an operational niche no other aircraft can approach.

The Osprey can carry 24 combat troops, or up to 20,000 pounds of internal cargo or 15,000 pounds of external cargo, at twice the speed of other helicopters. It features a cross-coupled drive system so either engine can power the rotors if one engine fails. For shipboard compatibility, the rotors fold and the wing rotates to minimize the aircraft’s footprint for storage. The V-22 is the only vertical lift platform capable of rapid self-deployment to any theater of operation, worldwide.

### General Characteristics

<table>
<thead>
<tr>
<th>Crew</th>
<th>Flight crew: USMC2/USAF3: Crew 24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width</td>
<td>Rotors turning: 84.6 ft. (25.78 m); Stowed: 18.4 ft. (5.61 m)</td>
</tr>
<tr>
<td>Length</td>
<td>Fuselage: 57.3 ft. (17.48 m); Stowed: 63.0 ft. (19.20 m)</td>
</tr>
<tr>
<td>Height</td>
<td>Nacelles vertical: Stabilizer: 17.9 ft. (5.46 m); 22.1 ft. (6.73 m)</td>
</tr>
<tr>
<td>Vertical takeoff max gross weight</td>
<td>52,600 lb.s (23,859 kg)</td>
</tr>
<tr>
<td>Max cruise speed</td>
<td>275 kt.s (443 km/h) SL</td>
</tr>
<tr>
<td>Mission radius</td>
<td>600 nm (722 km)</td>
</tr>
<tr>
<td>Propulsion</td>
<td>Two Rolls Royce AE1107C, 6,150 shp (4,586 kW) each</td>
</tr>
<tr>
<td>Rotor diameter</td>
<td>38.1 ft. (11.6 m)</td>
</tr>
</tbody>
</table>
Integrator is a multimission, long-endurance unmanned aerial vehicle (UAV) that carries custom payloads for intelligence, surveillance, and reconnaissance. The payload-centric design allows for easy integration with external systems.

Integrator has reconfigurable payload bays and maintains the same long endurance, modular construction, and small system footprint of the ScanEagle unmanned aircraft system (UAS). Missions can be pre-programmed and executed autonomously. Integrator ground control systems allow for seamless integration and expandability, multi-vehicle control, remote and mobile operations, and NATO-standard interfaces.

General Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wingspan</td>
<td>16 ft. (4.8 m)</td>
</tr>
<tr>
<td>Length</td>
<td>8.2 ft. (2.5 m)</td>
</tr>
<tr>
<td>Speed</td>
<td>Max horizontal speed: 90+ kt.s (46.3+ m/s); Cruise speed: 55 kt.s (28.3 m/s)</td>
</tr>
<tr>
<td>Endurance</td>
<td>24 hours</td>
</tr>
<tr>
<td>Max takeoff weight</td>
<td>135 lb.s (61.2 kg)</td>
</tr>
<tr>
<td>Empty weight</td>
<td>80 lb.s (36.0 kg)</td>
</tr>
<tr>
<td>Launch</td>
<td>Pneumatic catapult</td>
</tr>
<tr>
<td>Retrieval solution</td>
<td>No-nets, runway-independent Skyhook®</td>
</tr>
</tbody>
</table>
Phantom Eye is a hydrogen-powered high altitude long endurance (HALE) unmanned aerial vehicle system for persistent intelligence, surveillance, reconnaissance, and communications.

The Phantom Eye demonstrator is a propeller-driven, lightweight structure with a high aspect ratio wing. Its advanced propulsion system, coupled with Phantom Eye’s use of winds to stay on station, will enable Phantom Eye to provide persistent monitoring over large areas for up to four days.

Boeing also is developing a larger HALE that will stay aloft for 10 days and carry payloads of more than 2,000 pounds. HALE is designed to stay on station for 10 days with a 600-pound payload and 500-pound communications core. Typical payloads include multiple sensor packages for monitoring and tracking mission roles. In addition, when properly equipped, Phantom Eye can relay information across its 800-nautical-mile line of sight horizon.
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